International Journal of Advance Research in Science and Engineering
Volume No.07, Special Issue No.07, April 2018
www.ijarse.com
IJARSE
ISSN: 2319-8354

Role of Civil Engineering in The Preservation of OurArchitectural Heritage at Anjaneri

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ABSTRACT

Architectural restoration describes the process in which the material, historical, and design integrity of humanity's-builtpatrimony are prolonged through carefully planned interventions. The existence of old temples orancient structures will help us to observe the changes in the civilization for the better understanding of the reasons that lead to the development of cities and civilization and even traditions to the current status. Historical structures bring character and certain charm to the neighbourhood that people live in. Moreover, restoring an old building is often way cheaper than building the new one. Restoring locally important historical structures generates workplaces for both local people and international experts.

Innovation in architecture is extremely important, but conservation and restoring the old buildings is also important because those old structures are the reflection of our history, they help us to understand and respect people who lived in different eras or period with different habits and traditions. The key design feature of the present project is conservation of old temples and to maintain its originality without any alteration and modification. Here in this project we must restore Jain temples near Anjaneri village at Nashik

KEYWORDS

Geotechnical Study, Heritage, Restoration, Topography.

1. INTRODUCTION

Architectural conservation describes the process through which the material, historical, and design integrity of humanity's-built heritage are prolonged through carefully planned interventions. The existence of old templesor monuments will help us observe the changes in the societies for the better understanding of the reasons that lead to the development of cities and societies and even traditions to the current status. Historical structures bring character and certain charm to the neighborhood that people live in. Moreover, restoring an old building is often way cheaper than building the new one. Restoring locally important historical structures generates workplaces for both local people and international experts. Conservation and preservation of old buildings and monuments comes under the archeological survey of India(ASI).

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www.ijarse.com
IJARSE
ISSN: 2319-8354

Fig 1Dismental Temples at Anjaneri, Nashik

1.1 NECESSITY OF RESTORATION OF OLD STRUCTURES

- Historical monuments provide us information about our ancestors. How they live? What was the technology used at that time? We come to know about their culture.
- The existence of old temples/ monuments will help us observe the changes in the societies for the better understanding of the reasons that lead to the development of cities and societies and even traditions to the current status.
- Innovation in architecture is with no doubt extremely important, but preserving and restoring the old temples is also important because those old temples are the reflection of our history,
- They help us to understand and to respect people who lived in different eras with different habits and traditions.
- Old structures are the face of cities they reflect the changes that happened in a city over time, they reflect conflicts, wars and the prosperity of the society, it even reflects the economic condition of the city over time.
- Preservation of old structure plays an important cultural role in cultivating pride of our heritage and past making us unique in the world.
- As well when old structures attract tourist, that will definitely create more jobs for locals and help in improving the economic prosperity of the city, therefore maintaining historical structures provides work place for local people and expert from other countries.

1.2 SCOPE OF WORK

- The key design feature of the present project is conservation of old temples and to maintain its originality without any alteration and modification.
- Reconnaissance survey and Preliminary investigation.
- The surface soil was investigated through a few trial pits and by excavating soil sample up to a depth of 2 to 3 meters from the present ground level around the temples.
- The objective of the exploration work was to determine the probable sub surface Conditions such as stratification, denseness or hardness of the strata, position

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2 METHODOLOGIES

Before laboratory testing we conducted reconnaissance survey, in this we studied features like local topography, cutting, quarries, evidence of erosion, fills, water levels in wells and streams and drainage pattern. After that, for confirmation of the soil strata conditions at the foundation level, five trial pits measuring 1.5m × 1.5m × 2m were excavated adjacent to the plinth walls of some important structures in the temple complex. A total number of 22 soil samples have been collected for taking up various laboratory tests. A flowchart of the investigation is as follows:

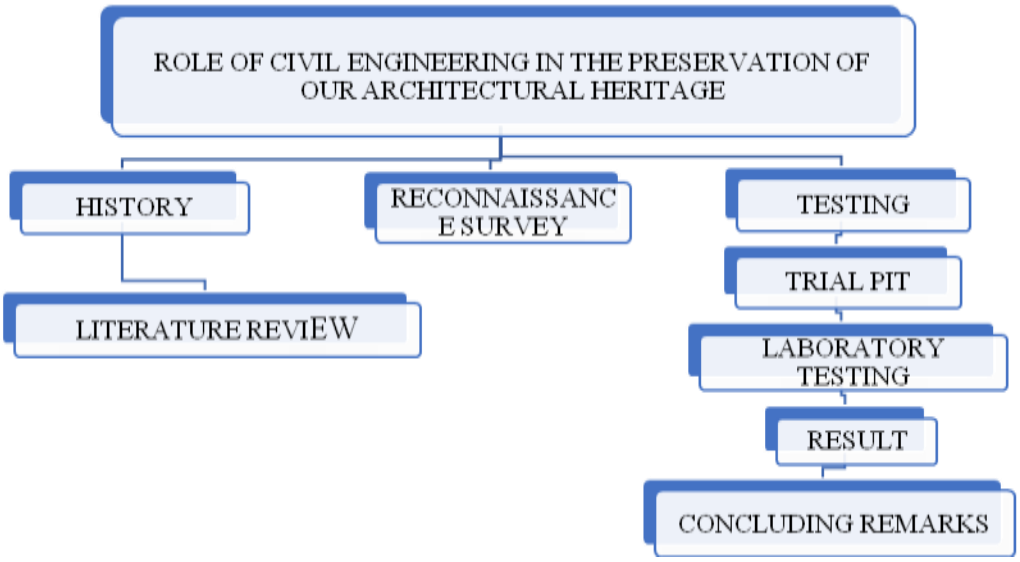

FIG. 2 . FLOWCHART

2.1 RECONNAISSANCE SURVEY

Reconnaissance surveys represent a type of field survey that is often used to gather initial information regarding the presence or absence of historic properties within a project area.an investigation of site is essential for judging the suitable methods for the proposed restoration work and for preparing adequate and economic design.an inspection of the site and study of topographical features is often helpful in getting useful information about soil and ground water conditions and in deciding the future program of restoration. Ongoing over the site, we studied features like local topography, cutting, quarries, evidence of erosion, fills, water levels in wells and streams and drainage pattern.

2.2 TO FULFILL THE OBJECTIVE, THE WORK CARRIED OUT IS COMPRISES

Excavating trial pits up to the depth of 2m below existing ground level to know the sub surface stratification, conducting necessary field tests and to collect Disturbs soil samples for laboratory testing. Testing soil samples in the laboratory to determine its Index and engineering Properties of the soil samples. The work was in general accordance with IS: 1892 – 1979.

2.3 TRIAL PIT

For confirmation of the soil strata conditions at the foundation level, five trial pits measuring 1.5m × 1.5m × 2m were excavated adjacent to the plinth walls of some important structures in the temple complex. The trial pit is

located around the 4 corners of various temples. These pits revealed that the strata are essentially silty/sandy clay beyond 1.6m to 2m from the present ground level. The soil at 2.5m depth is plastic clayey. No hard strata are available at a shallow depth and the surface soil does not have any significant swelling characteristics. Representative soil samples were collected from each pit for necessary laboratory tests and to identify/classify the soil. The tests were conducted at the Geotechnical Engineering Laboratory at Late G. N. Sapkal C.O.E., Nashik.

2.4 DISTURBED SAMPLES

Disturbed representative samples were collected, logged, labelled and placed in polythene bags.

2.4.1 Samples collected from Pit 1

In this pit disturbed soil samples have been collected for conducting various laboratory tests so as to find out the foundation soil formations and their index properties. Visual inspection of the walls of the trial pit and the soil samples collected at different depths of the auger hole indicate that a thick layer of murrum exists just below the ground up to the depth of 2m. The mentioned murrum is expected to be filled up, so as to avoid excessive settlement problem of the clayey sandy soil formations. Further, the soil samples collected in the trial pits also indicate that the plasticity of the foundation soils increases with increase in depth up to the explored depth.

2.4.2 Samples collected from Pit 2

The depth of the pit excavated was 102cm. six representative disturbed soil samples were collected for conducting various laboratory tests. In addition, one undisturbed short core cutter sample was also collected in the clayey layer below the foundation footing and to determine the in-situ dry density and moisture content.

2.4.3 Samples collected from Pit 3

Five disturbed soil samples were collected in this pit as indicated in the log of pit. Based on the visual of the walls of the excavated pit and the collected representative soil samples at different depths of auger holes, it is revealed that the foundation soil consists of about 60cm thick filled up rock fragments followed by about 60 cm thick filled up rock fragments followed by about 45cm thick filled up sand layer. Below this sand layer, it could be observed that clay dominated soil formations (with increase in plasticity as the depth increases) was found.

2.4.4 Samples collected from Pit 4

Due to existence of crossings of multiple tree roots within a very shallow depth. In addition, two disturbed soil samples were also collected from the top layers for conducting soil classification tests on the same. Due to the tree roots in this pit, soil sample could not be collected and investigated.

3. RESTORATION

Returning to a known earlier state without the introduction of new materials.

3.1 RESTORATION TECHNIQUES

1. Reversible
2. Irreversible

Reversible action may be preferable as they can be subsequently replaced without damage to the original fabric.it may not be possible to use reversible methods for intervention, and some intervention cannot be easily undone without causing damage to the existing structure.

4. INTERPRETATION OF THE TEST RESULTS

Based on the soil classification tests, the foundation soil formations found to be almost uniform within the temple complex. Further, the foundation soil samples are dominated with fine sand/silt size materials. The plasticity characteristics of the foundation soils found to be increasing with increase in depth. Considering dry density of the foundation and the weight of the structure, it is expected that the structure might have undergone excessive post construction settlement. Since the plasticity index of the foundation soil is found to increase with increase in depths, the soil formations have undergone shrinkage and swelling during dry and wet seasons respectively. Depending upon the intensity of volume reduction and increment, the structures, might have encountered excessive settlement/vertical cracks and structural failures.

Table No. 1. Soil Sample from pit 1 and 2

SR. NO.	TEST NAME		Pit 1 at 1m depth	Pit 1 at 2m depth	Pit 2 at 1m depth	Pit 2 at 2m depth
1	PARTICAL SIZE DISTRIBUTION	C_c	1.68	2.2	2.55	1.52
		C_u	8	13.33	7.5	9.52
2	SPECIFIC GRAVITY BY PYCNOMETER	G	2.26	2.57	2.43	2.96
3	ATTERBERG LIMIT					
	a) liquid limit	LL	59.28	55.23	62.50%	52.00%
		FI	862.19	175.25	102.19	51.08
	b) plastic limit	PL.	41.67	37.58	49.99%	41.66%
		PI	24.33	17.4	12.51	10.34
		TI	0.028	0.1	0.1224	0.202
	c) shrinkage limit	Ws	14.44	18.23	28.56%	14.69%
		SR	1.74	1.52	1.4	1.44
		Vs	0.0575	0.53	0.7	0.69
4	STANDARD PROCTOR TEST	MDD gm/cu.cm	1.68	1.638	1.569	1.75

		OMC	17.8	16.00	12.2%	12%
5	DIFFERENTIAL FREE SWELL	FSI	18.18 %	19.23	10.86%	16.67%
6	DETERMINATION OF FIELD DENSITY	ρ g/cc	1.68	1.77	1.70	1.87

Table No.2 Soil Sample frompit 3 and 4

SR. NO.	TEST NAME		Pit 3 at 1m depth	Pit 3 at 2m depth	Pit 4 at 1m depth	Pit 4 at 2m depth
1	PARTICAL SIZE DISTRIBUTION	C_c	2.79	3.4	1.34	1.55
		C_u	6.97	7.35	15.45	13
2	Specific Gravity By Pycnometer	G	2.42	2.2	2.31	2.54
3	ATTERBERG LIMIT					
	a) liquid limit	LL	65.78%	50 %	45%	46 %
		FI	93.24	80.72	40.991	54.35
	b) plastic limit	PL.	50%	29 %	26.65 %	24.28 %
		PI	15.78 %	21 %	18.35 %	21.71 %
		TI	0.16	0.26	0.44	0.39
	c) shrinkage limit	Ws	21.075 %	30.135 %	27.99 %	36.51 %
		SR	1.46	1.51	1.42	1.23
		Vs	0.46	0.48	0.40	0.24
4	STANDARD PROCTOR TEST	MDD gm/cu.cm	1.63	1.52	1.6	1.68
		OMC	19.4 %	23 %	16.2%	16.3 %
5	DIFFERENTIAL FREE SWELL	FSI	35.92%	30 %	25%	20 %
6	Determination Of Field Density	ρ g/cc	1.57	1.63	1.67	1.71

4.1 FOUNDATION ANALYSIS

The damage too many of the structure components of the temple structures may be attributed to the foundation movements and tree root penetration leading to splitting of plinth stones and escape of soil under the plinth.

4.1.1 Geotechnical issues

Long term settlement is due to:

a. Pressure on clay layers at deeper levels

b. Escape of plinth fill soil through the gap between the stones

c. Due to root penetration.

4.1.2 Strata conditions

The strata condition of Temple generally comprises of silty sand with occasional layers of clay at the surface. An average strata condition based on the information available in the neighbouring area is shown in the table. It is believed that the layers have already undergone elastic compression and consolidation. Data on settlement in the past indicate that settlement occurring under the present load is complete. Data on future settlement of the structure is not available, unless it is obtained by placing additional weight (in excess of what existed in the past). Therefore, there is no threat of damage to the restored portion of the temple on account of settlement.

4.1.3 Details of Foundation

The temple is supported on compacted clayey gravels which is confined by plinth wall comprising of an inner layer of basalt and trap stone. The depth up to which the plinth wall extends below the existing ground level varies from 1.5m – 2m depending on the extent of the soil deposition in the area. Some of the interior columns and walls do not have a foundation extending below the natural ground and these are supported directly on the compacted clayey gravels fill above the natural ground level on a layer of sand stone followed by a layer of basalt and trap stone. Ideally, each of the columns and walls should have extended below the natural ground level and provided with foundation to distribute the load over a wider base area.

4.1.4 Deficiencies in The Foundation

If the plinth wall remains intact, the compacted sand within the plinth wall has adequate capacity to support the columns and walls with settlements not exceeding the permissible limits. However, the following phenomena have resulted in large scale damage to the compacted plinth fill:

- Entry of tree roots have separated the stones in the plinth wall (both sand stone and laterite stones) and created a gap at some of the dry joints.
- The direct rainfall or flood water which penetrates the plinth area through the open joints in the flooring has escaped through such open joints and carried large quantity of silt/sand from the plinth fill.
- The escape of plinth fill material along with water has results in large settlement of the plinth floor, columns and walls.
- At certain locations, the floor has sunk to such at some extent which leads to fall of arch of the entrance gallery roof has collapsed.
- In some places the column may be shift form its center line and it does not match with the center of basalt or trap stone of the plinth floor on which the column has been supported. At certain location, the column is supported on the edge of the basalt or trap stone of the plinth floor. This results in eccentric loading on the plinth floor.

- At present no drainage system is noticed for the surface water to drain out during rains. It is possible that the drainage provided during construction of the temple has been buried under the sediments which are deposited by the flood over years. In the absence of any drains, the plinth fill can remain saturated for a longer period and it will have much reduced capacity to carry the load from columns/ walls

5. CONCLUSIONS

Based on the visual inspections of the temple area, soil samples collected at different depths and the results of the basic soil classification tests the following preliminary conclusions were drawn:

- From soil identification test the colour of soil is brownish black which suggest the given soil is black cotton soil. Also, it has distinct odour and dark colour it also reveals that the given soil sample is organic soil.
- From consistency limits and with the help of plasticity chart we can conclude the given soil sample is organic silt or organic soil with high plasticity.
- From the particle size distribution curve, it is clear that given soil type is well graded coarse grain soil. Which suggest that soil having good shear strength.
- The value of specific gravity does not lie in the rage of 2.65-2.80; hence it is organic soil having variable specific gravity.
- Suitability of soil for back filling: the soil is of low degree of expansiveness i.e. Swelling characteristics which is suitable for back filing.
- Some temples are totally dismantled due to the lack of maintenance and adverse climatic condition (heavy rainfall) in given area.
- By analysing temple and foundation condition, it is clear that foundation is in good condition except in some region there are some settlement is observed.
- Also, there is large extent cutting and filling around the temple site, which is affect the stability of Temples and it is responsible for damages.
- Displacement/over compressions of the stone blocks of the various structures are due to penetration of the roots.
- Use of two different types of stones, porous and fine-grained sand stone and highly porous grained laterite stone in the construction of the various structures.
- The plasticity characteristics of the foundation soil are found to increase with increase in depths.
- This was undertaken for preliminary assessment of the surface soil conditions. Five trial pits adjacent to the plinth walls of same structures within the temple complex were excavated to understand the soil strata conditions at the foundation level.

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